Enthalpy and Stoichiometry

1. Consider the following unbalanced equation. How many kJ of heat are consumed when 5.69 moles of solid iron react? Is this reaction endothermic or exothermic?

   Al_2O_3 (s) + Fe (s) → Al (s) + Fe_2O_3 (s) ΔH = +852 kJ

   The reaction is **endothermic**

   Al_2O_3 (s) + **2** Fe (s) → **2** Al (s) + Fe_2O_3 (s) ΔH = +852 kJ

   $5.69\ mol\ Fe \times \frac{852\ kJ}{2\ mol\ Fe} = \mathbf{2.42 \times 10^3\ kJ}$

2. Consider the following reaction:

   N_2 (g) + O_2 (g) → 2 NO (g) ΔH = +181.8 kJ

   a) is the reaction endothermic or exothermic?

   endothermic

   b) Calculate the enthalpy change when 32.65 g of NO is produced.

   M_m NO = 30.01 g/mol

   $$32.65\ g\ NO \times \frac{1\ mol\ NO}{30.01\ g\ NO} \times \frac{181.8\ kJ}{2\ mol\ NO} = \mathbf{98.90\ kJ}$$

3. Write a balanced chemical equation for the combustion of methanol, CH_3OH in oxygen (O_2); the reaction gives off 727 kJ of heat. Calculate the enthalpy change when 12.56 g of methanol undergoes combustion in excess oxygen.

   2 CH_3OH (l) + 3 O_2 (g) → 2 CO_2 (g) + 4 H_2O (g) ΔH = -727 kJ

   M_m CH_3OH = 32.04 g/mol

   $12.56\ g\ CH_3OH \times \frac{1\ mol\ CH_3OH}{32.04\ g} \times \frac{727\ kJ}{2\ mol\ CH_3OH} = \mathbf{142\ kJ}$

4. The enthalpy change when 1 mole of CH_4 is burned is -890 kJ. To vaporize one mole of water it takes 44.0 kJ of heat. What mass of methane must be burned (in oxygen) to provide the heat required to vaporize 1.50 g of water?

   CH_4 (g) + 2 O_2 (g) → CO_2 (g) + 2 H_2O (g)

   H_2O (l) → H_2O (g)

   $1.50\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.02\ g} \times \frac{44.0\ kJ}{1\ mol\ H_2O} \times \frac{1\ mol\ CH_4}{890\ J} \times \frac{16.04\ g\ CH_4}{1\ mol\ CH_4} = \mathbf{0.0660\ g\ CH_4}$